FUMIGATION WITH FORMALDEHYDE.

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Being an account of some experiments conducted at the Newton (Mass.) Hospital with four different formaldehyde generators, the results of which indicate the inefficiency of these forms of apparatus to entirely disinfect rooms, when operated under conditions purporting to kill all pathogenic bacteria as existing in these rooms.

Since the discovery of the antiseptic and disinfecting properties of formalin, particularly formaldehyde, modern methods of fumigation have been carefully studied with the hope, and perhaps the conviction, that at last the ideal gaseous disinfectant had been found. This study has given birth to several ingenious devices designed to generate in one way or another the gas formaldehyde. Some of these forms of apparatus have been put on the market, claiming to completely disinfect rooms of a given size when operated under given conditions. Without doubt all such claims on the part of the manufacturers have been made with perfect honesty, because so many of the earlier experiments with this gas gave apparent evidence of its marvellous bactericidal quality. Pathogenic bacteria were said to be killed by short exposures to the gas. Le Roux, Bosc, Trillat, and others gave reports with very favorable results. But it is not intended here to enter into the history of these numerous experiments. Suffice it to say that some of the later results, particularly in the United States, would indicate that too much had been claimed for this gas, as to its rapidity of action and bactericidal efficiency, particularly as generated or regenerated by these various generators. And in this connection it was thought to be of sufficient interest and practical importance to place before this Association an account of some work undertaken last July and August at the Newton (Mass.) Hospital. A small room of about 1,870 cubic feet capacity was subjected to the action of this formaldehyde from each of four different generators. All conditions were kept as much as possible like those usually met with in the ordinary house-fumigation work of boards of health. Each apparatus was given a test under exactly the same conditions as its competitors, and each test was repeated at least once, sometimes three or four times. The fundamental idea in this series of experiments was to compare the germicidal action of these generators when operated under conditions prescribed as most efficient, in order to determine, if possible, the best one for board of health use.

To be more specific, the forms of apparatus used were the Trillat Autoclave, manufactured by Fries Bros. of New York, the Autoclave of

the Sanitary Construction Company of New York, the Robinson Generator, and the Moffatt No. 3 (four tube) Generator of Eli Lilly & Co., Indianapolis. The first two, those of the autoclave type, depend on the regeneration or evaporation under pressure and rapid discharge of the formaldehyde gas from a mixture of the 40 per cent. formalin solution with a solution of some salt, such as calcium chloride. In the third form, the Robinson generator, the gas is formed by passing the vapor of methyl alcohol through glowing platinized asbestos. And the fourth, the Lilly lamp, manufactures the gas by simply regulating the combustion of methyl alcohol.

In the case of the Trillat autoclave which was the first to be tried, the agent from Fries Bros. was on hand to operate the apparatus. All the conditions, such as capacity and tightness of room, the working of his apparatus and so on, he pronounced entirely satisfactory. Carefully dried on sterilized coverslips, cultures of *bacillus diphtheriæ*, *bacillus anthracis*, *bacillus typhi-abdominalis*, *bacillus coli communis*, *and staphylococcus pyogenes albus* were placed in the room in an exposed position. The room was then closed, and all cracks about the door carefully padded with cotton.

The autoclave operated during the required time,—the room remained closed for six hours,—and then, as soon as it was possible to enter the room, the infected coverslips were removed to the laboratory, where each one was partially imbedded in thin solid agar films in Petri dishes. In from five to eight days' incubation at the temperature of the room (about 23°C) growths were obtained from all these fumigated coverslips except those infected with the *typhoid bacillus*. All control cultures gave vigorous growths within forty-eight hours under the same conditions. When after six or seven days' incubation, no growth appeared on exposed coverslips as imbedded in the agar film, by taking a platinum needle and carefully scraping it over infected part of coverslips and inoculating serum tubes therewith, growths were obtained on the serum within twenty-four hours at 37½° C., with all cultures which were treated in this way except typhoid.

Fries Brothers' circular makes this statement: "It is preferable to allow the vapors of formaldehyde gas to remain as long as possible, but from three to four hours' contact is sufficient for a good superficial disinfection."

On the two days when this autoclave was operated, *six hours'* contact was allowed. And the infectious material dried on coverslips, was certainly open to "superficial disinfection." With the exception of the *bacillus typhi abdominalis*, the exposed bacteria were not all killed by this Trillat autoclave. It did, however, have the effect of greatly inhibiting their growth as is shown by comparing the time required to obtain growths from the exposed cultures with that of the controls,—five to eight days in the former, and one to two days in the latter case.

The Sanitary Construction Company's autoclave (from Melvin & Badger, Boston) was given a test on three different days, the same germs being exposed in the same manner as with preceding autoclave for the same length of time, six hours. The results were approximately the same as with the first apparatus, all cultures exhibiting growths except *typhoid.*

In the circular issued by Melvin & Badger it is concluded from experiments therein cited that "formaldehyde gas, as regenerated in this apparatus, will undoubtedly destroy all germs of a pathogenic nature during an exposure of four hours." At the Newton hospital this apparatus was given *six* hours' trial in quite a small room, resulting in the survival of such pathogenic forms as *diphtheria* and *anthrax.*

The Robinson generator was put through the same test of six hours on the same germs, and the same results were obtained. *Typhoid* was the only culture that was absolutely killed.

The fourth and last form of apparatus used was the Lilly Lamp No. 3. In this case again, *typhoid* was the only one that was killed. In the circular accompanying this lamp it is said: "As the result of a long and carefully conducted series of experiments by expert bacteriologists we recommend that in order to completely destroy all pathogenic germs by this apparatus it be allowed to burn ninety minutes for each 1,500 cubic feet, then withdraw the generator from the room and do not air for several hours." In these cases the apparatus was allowed to burn itself out without removing from the room. In this way the lamp would burn for about five hours.

After completing the formaldehyde experiments, *sulphur* was burned in the same room in order to compare its effects on the same series of germs. With the exception of *typhoid* all the cultures, *diphtheria, anthrax, coli and staphylococcus pyogenes albus* grew as rapidly as the controls, that is, inside of forty-eight hours.

To be just to the manufacturers and agents of these particular generators, I would say that in some instances they have materially changed the size or form of apparatus since these experiments were undertaken. For example, I understand that the Moffatt generator No. 3 is no longer made by its manufacturers, Lilly & Co., but has given place to a much larger form, which is said to fulfill requirements of the U. S. Marine Hospital Service.

From the results of the experiments herein reported, it was impossible to recommend one form of apparatus more than another. Each did the same germicidal work. Each was considerably better than sulphur as that is ordinarily used. No attempt was made at any time to determine the percentage of formaldehyde gas in the room. Neither were any inoculation experiments made on animals to determine whether or not the virulence of the germs was changed by exposure to the gas. The principal conclusion from these results was this, that the generators did

not kill all the pathogenic forms as they claimed to do in a certain time and space.

It is not my desire to give the impression that I do not believe in formaldehyde, and that I do not favor the use of these generators. But I have no confidence in the almost ideal claims that are made for them upon such a small amount of evidence. Are we ready to-day to make definite statements in regard to the absolute size of room and exact time of exposure necessary for this gas to kill bacteria of certain kinds? There are so many conditions, particularly as to the age and nature of cultures exposed, the method of exposing artificial laboratory cultures and natural culture material from diseased bodies, and various unknown quantities of this sort, all of which enter directly into the results, that a very long and complete chapter of results must necessarily be tabulated and studied before we know just what the gas will do. To-day as a result of experiments conducted by the government and others, we are, perhaps, nearer the truth as to its efficiency as a room disinfectant. We are beginning to understand that the claims for the gas and for the generators of the gas have been too ideal and have not stood the test. And it has been to emphasize this fact that I have taken the liberty to present this paper. I firmly believe that under the proper conditions the gas will kill the pathogenic germs; but in the light of such varying results it seems impossible to set a definite formula for room disinfection. However, for all practical work as far as we know at present, formaldehyde is the best gaseous disinfectant.